ECOLOGY, BEHAVIOR AND BIONOMICS

The Flowering-Visiting Bees at the Ecological Station of the Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil

YASMINE ANTONINI AND ROGÉRIO P. MARTINS

Lab. Ecologia e Comportamento de Insetos, Depto. Biologia Geral, ICB, UFMG. Av. Antônio Carlos, 6627, C. postal 486, 31270-901, Belo Horizonte, MG

Neotropical Entomology 32(4):565-575 (2003)

A Fauna de Abelhas e Suas Plantas Hospedeiras na Estação Ecológica da UFMG, Belo Horizonte, MG

RESUMO - Inventariaram-se as espécies de abelhas silvestres da Estação Ecológica do Campus Pampulha da Universidade Federal de Minas Gerais, que é localizada em uma área intensamente urbanizada. As abelhas foram coletadas de janeiro a dezembro de 1996, quando visitavam plantas floridas. A fauna de abelhas é rica em espécies, mas suas populações têm baixas densidades (350 indivíduos em 98 espécies). A composição em espécies é sazonal (Q = 29,35; gl = 11; P < 0,002), entretanto composição em espécies das plantas floridas não é sazonal (Q = 17.30, gl = 11, P < 0,099). As abelhas visitaram 23 espécies de plantas em 11 famílias. Asteraceae (111 indivíduos de 53 espécies) e Convolvulaceae (88 indivíduos de 26 espécies) foram as mais visitadas. Houve uma correlação positiva entre a abundância de abelhas e o número de plantas floridas ($r^2 = 0,72$; P = 0,0011, n = 12) e entre a riqueza e abundância de plantas floridas ($r^2 = 0,46$; P = 0,010, n = 12). Na área estudada e em outros locais da Região Sudeste, Apidae foi a mais rica e abundante e na Região Sul do Brasil, Halictidae foi a mais rica e abundante. Apesar de circundada por área intensamente urbanizada, a estação ecológica mantém uma apifauna relativamente rica.

PALAVRAS-CHAVE: Fauna de abelhas, planta florida, fragmento florestal urbano

ABSTRACT - The richness and the composition of bee species at the ecological station of the Universidade Federal de Minas Gerais, Campus Pampulha, Belo Horizonte, MG, Brazil, was recorded from January to December 1996. The bee fauna of the ecological station is rich (98 species) in low-density populations species (350 individuals). The composition of the bee fauna is seasonal (Q = 29.35, df = 11, P < 0.002), however the composition in flowering plants showed no seasonality (Q = 17.30, df = 11, P < 0,099). The bee species visited 23 flowering plant species from 11 families. Asteraceae (111 individuals in 53 species) and Convolvulaceae (88 individuals in 26 species) were the most visited families. There was a positive relation between bee abundance and the number of flowering plants ($r^2 = 0.72$, P = 0.0011, n = 12) and bee richness and abundance of flowering plants ($r^2 = 0.46$; P = 0.010, n = 12). In the studied area and other sites at Southeastern Brazil, Apidae was the richer and abundant family and Halictidae was the richer and abundant at South Brazil. Despite its localization in a heavily urbanized area, the ecological station supports a rich bee species assembly.

KEY WORDS: Bee fauna, flowering plant, fragment of forest

The increasing habitat devastation makes studies on biodiversity a priority. Except from some relatively well-studied bee groups such as the Meliponinae, the biology of most of neotropical bee fauna is poorly known, in spite of its importance for the maintenance of communities of plants and their pollinators. In the "cerrados", for instance, about 80% of the plant are pollinated by bees (Gottsberger *et al.* 1988).

Bee assemblages and their association with host plants have been studied in Brazil (see Pinheiro-Machado 2002 for a revision). Cure *et al.* (1992, 1993), Silveira & Cure (1993), and Silveira *et al.* (1993) reported upon species surveys in secondary forests and abandoned pastures at the "Zona da Mata" of Minas Gerais State. Silveira & Campos (1995) and Carvalho & Bego (1998) sampled some cerrado areas. Notwithstanding, many bee species remained unidentified in these studies because they were probably unclassified species (Pinheiro-Machado, 2002).

Except for the surveys performed in Curitiba State (South Brazil) (Sakagami *et al.*1967; Laroca *et al.* 1982; Bortoli & Laroca 1990, 1997), there are no studies on bees and its associated plants at urban biotopes for others metropolitan regions of Brazil. This is the first study on the wild bee fauna at an urban biotope from the Metallurgic Zone of Minas Gerais.

Material and Methods

The ecological station of the Universidade Federal de Minas Gerais is located at the Campus-Pampulha, in the Belo Horizonte municipality (19º52'S, 43º58'W). Belo Horizonte is located at a mean altitude of 930 m, in the boundaries between the Atlantic Forest and the Cerrado phytogeographical provinces. The region is divided by chains of mountains that reach maxima altitudes of 1500 m. In such altitudes, rupestrian fields dominate the landscape.

The ecological station has by now been preserved for about 50 years. It encompasses forest and "cerrado" vegetation patches, besides other impacted areas dominated by weeds, and a swamp area dominated by species of *Ludwigia* (Onagraceae). The trails and firebreaks of the area are nesting sites for several ground nesting digger wasps and bees species (Martins & Almeida 1994, Martins & Antonini 1994, Martins *et al.* 1996).

The regional climate has a well-defined dry and wet seasons. During the study period (Jan-Dez, 1996) June and July were the driest and coldest months, with average temperatures of 18°C and 19°C, respectively (Fig. 1).

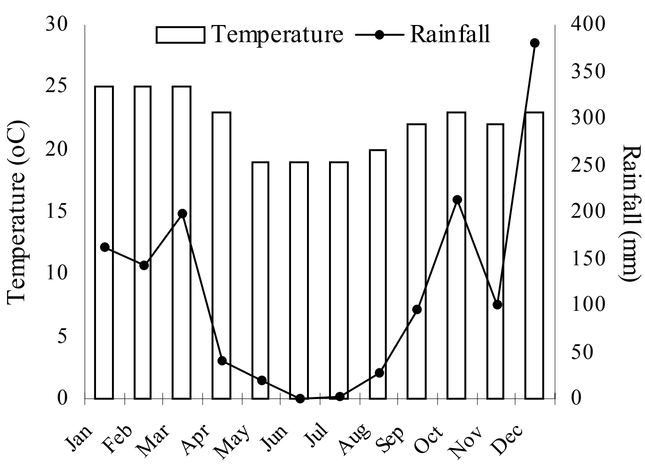

Figure1. Monthly average of temperature and rainfall from January to December of 1996 at the ecological station of UFMG, Belo Horizonte, MG, Brazil.

The bee fauna was intensively sampled surveyed each week, from January to December 1996, between 9:00h and 15:00h, when most of the species were active. From February to April 1996, samples were done each 15 days due to the higher frequency of rainy days, when the frequency of pollen and nectar gathering by the bees diminishing. Sampling precedure was according to Sakagami *et al.* (1967). Bees were searched for in flowering plants, caught with entomological nets, killed in a killer chamber, and stored in individual paper bags. The sampler remained 10 min. close to individual flowering plants, and also in patches in excess of individuals of the same species (*Cosmus sulphureus* Asteraceae, for instance). In these patches sampling time was increased to 30 min. Three sites were sampled: two firewalks in an area dominated by weeds and some shrubs (disturbed area 1 – D1); an open area surrounded by a swamp dominated by *Ludwigia* spp. (disturbed area 2 – D2) and two firewalks alongside an area of secondary forest.

Trees higher than 5 m, whose canopy could not be reached by entomological nets, were excluded from the samples. *Apis mellifera* L. and *Trigona spinipes* Fabricius, two very abundant species at the study site, were not captured though their occurrence was recorded. Samples were taken from the flowering plants in which bees had been collected. These samples were deposited in the herbarium of the Departamento de Botânica of the UFMG (BHCB).

In order to compare similarities in species composition among sampled areas, the Renkonen index was used as recommended for the cases of small samples (Wolda 1981).

Standartized bee abundance was expressed by the number of sampled individuals divided by the number of sampling hours (Silveira *et al.* 1993). The relation between bee abundance and richness of flowering plants was tested by a linear regression.

The Q test of Cochran (Zar 1998) was used to test for seasonality in composition of bee species and the flowering plants they visited. In order to detect possible monthly variations in species composition, the Sorensen index of similarity was also calculated. A curve of species accumulation was made to show the trend of accumulation of new species.

The species list for the ecological station was completed with the inclusion of 24 species collected in the area from 1993 to 1995 by members of the Laboratório de Ecologia e Comportamento de Insetos (ICB, UFMG), notwithstanding these records were not included in the present analyses.

The richness and abundance of species in each family, the percentual of bee species and individuals collected in this study was compared to data obtained in Minas Gerais State, Paraná State and São Paulo State.

Results

Bee Diversity. A total of 350 specimens from 98 species, 47 genera, and five families were collected (Table 1). Eighty-two specimens were collected at disturbed area 1 (D1), 29 at disturbed area 2 (D2), and 40 at the forested area. Forty-one out of 98 species occurred in the three areas, 15.2% only in the forested area and D1, 4.34% only in the forested area and D2, and 6.53% only in D1 and D2.

Twenty-four different species had been already registered in the reference collection from the Laboratório de Ecologia e Comportamento de Insetos, ICB, adding up to 122 species at the ecological station (Table 1).

There was a rapid increasing (33) in the number of species captured between January and April (Fig. 2). A few new species were captured monthly until December. Thus, the cumulative number of species at the area has not stabilized (Fig. 2). There was no difference in the average number of sampled species between rain and dry periods (11 ± 8.5; 5 ± 2; t = 1,69, P > 0.05, gl = 10).

Table 1. Number of individuals of bee species collected at the Ecological Station of UFMG from January to December of 1996. D1 = Disturbed area 1; D2 = Disturbed area 2; F = Forest edge; T = total; x = bees species occurring at the ecological station but not captured during this work (they were not numbered) and ● indicate the presence of bee species in the month.

Species	Areas				Months												Visited plant species*
	D1	D2	F	T	J	F	M	A	M	J	J	A	S	O	N	D	
ANDRENIDAE																	
OXAEINAE																	
Oxaea flavescens Klug	1	0	0	1									●				14
PANURGINAE																	
Acamptopoeum sp.				×													
Acamptopoeum prinii (Holmberg)				×													
Psaenythia sp.1				×													
APIDAE																	
APINAE																	
APINI																	
Apini sp.1	0	0	1	1				●									
Apis mellifera L.	×	×	×														
Bombus atratus Franklin	9	8	3	20	●		●	●	●	●		●	●	●	●	●	4, 6, 8, 9, 19, 21
Bombus morio Swederus	2	1	2	5			●	●						●		●	4, 6, 8, 9, 19, 21
Euglossa leucotricha Rebelo & Moure				×													
Euglossa modestior Dressler				×													
Euglossa sp.				x													
Eulaema nigrita Lepeletier	3	0	0	3							●						Vôo
Geotrigona subterranea Friese	4	2	1	7	●	●		●	●	●						●	2, 4, 19,
Melipona quadrifasciata anthidioides Lepeletier	0	0	1	1						●							6
Nannotrigona testaceicornis Lepeletier	3	0	0	3										●			13
Paratrigona lineata Lepeletier	6	3	1	10	●		●		●	●	●	●	●				3, 4, 11, 15, 18
Partamona helleri Friese	0	0	1	1	●												2
Tetragonisca angustula Latreille	1	0	2	3				●					●				4,18
Trigona spinipes Fabricius	×	×	×														
CENTRIDINI																	
Centris aenea Lepeletier	8	1	0	9			●	●	●	●							4, 12, 21, 6
Centris (Hemisiella) trigonoides Lepeletier	3	1	2	6			●	●			●		●				12, 21
Centris sp.1	1	0	0	1				●									
Centris collaris Lepeletier	3	0	0	3	●		●										7,12
Centris xanthocnemis Perty				×													
Centris similis Fabricius	4	0	0	4			●										12
Centris fuscata Lepeletier	1	0	0	1			●										12
Epicharis flava Friese	1	0	0	1		●											16
Epicharis sp.				×													
Epicharis affinis Smith	1	0	1	2		●	●										16
EUCERINI																	
Eucerini sp.1	0	0	1	1				●									
Melissodes sexcincta Lepeletier	0	1	1	2			●	●									4
Melissodes nigroaenea Smith	1	1	0	2	●			●									4, 8
Melissoptila cnecomola Friese	5	4	2	11			●	●	●	●							4, 17, 19
Melissoptila paraguayensis Scrottky	0	1	0	1			●										4

Continue...

Table 1. Continuation

Species	Areas				Months												Visited plant species*
	D1	D2	F	T	J	F	M	A	M	J	J	A	S	O	N	D	
EMPHORINI																	
Ancyloscelis sp.1	0	4	1	5			●	●									8
Ancyloscelis apiformis Fabricius	2	2	1	5			●			●	●						9, 10
Diadasina distincta Holmberg	1	2	2	5			●	●					●				19
Melitoma segmentaria Fabricius	7	2	0	9							●	●	●	●			9, 14,
Ptilothrix plumata Smith				×													
EXOMALOPSINI																	
Exomalopsis analis Spinola				×													
Exomalopsis auropilosa Spinola	3	1	0	4				●		●	●		●				4, 15, 17, 21
Exomalopsis collaris Friese	2	0	0	2										●	●		8, 21
Exomalopsis fernandoi Moure	1	0	0	1				●									
Exomalopsis minor Schrottky	1	0	0	1										●			3
Exomalopsis subtilis Timberlake	1	0	0	1												●	4
Exomalopsis (Exomalopsis) tomentosa Friese	0	0	1	1									●				21
RHATHYMINI																	
Rhathymus bicolor Lepeletier and Fabricius				×													
TAPINOTASPINI																	
Paratetrapedia sp.2	0	0	4	4			●								●		4, 9
Monoeca sp.1	0	1	1	2				●									4
TETRAPEDIINI																	
Coelioxoides waltheriae Ducke				x													
Tetrapedia sp.7	2	0	0	2											●	●	8, 4
Tetrapedia sp.8	0	0	1	1								●					8
ERICROCIDINI																	
Mesoplia sp.2	1	0	0	1			●										12
NOMADINAE																	
EPEOLINI																	
Thalestria spinosa Fabricius	0	1	0	1													Vôo
Doeringiella cingillata Moure				×													
NOMADINI																	
Nomada sp				×													
PROTEPEOLINI																	
Leiopodus lacertinus Smith	1	0	0	1						●							9
XYLOCOPINAE																	
CERATININI																	
Ceratina sp.1	2	0	0	2	●										●		9
Ceratina sp.2	6	0	0	6	●							●	●		●	●	9,4
Ceratina sp.3	3	0	3	6								●		●	●		4, 9
Ceratina sp.5	36	0	3	39	●		●			●	●	●	●	●	●	●	4, 7, 9, 14, 15, 17
Ceratina sp.6	1	0	0	1						●							
Ceratina sp.7	1	1	0	2						●		●					6
Ceratina sp.8	2	0	0	2												●	4
Ceratina sp.10	1	0	0	1	●												11
Ceratina sp.14	1	0	0	1											●		4
Ceratinula sp.3	0	0	1	1	●												
Ceratinula sp.4	4	0	0	4	●												3
Ceratinula sp.6	1	0	0	1	●												3

Continue...

Table 1. Continuation

Species	Areas				Months												Visited plant species*
	D1	D2	F	T	J	F	M	A	M	J	J	A	S	O	N	D	
XYLOCOPINI																	
Xylocopa muscaria Fabricius	1	0	0	1				●									
Xylocopa nogueirae Hurd&Moure	1	0	0	1					●								4
Xylocopa subcyanea Perez	2	0	0	2						●	●						6
Xylocopa suspecta Moure & Camargo	2	0	1	3	●					●		●					7,11, 20
COLLETIDAE																	
COLLETINAE																	
PARACOLLETINI																	
Eulonchopria psaenythioides Brethes				×													
Tetraglossula anthracina Michener	0	3	3	6			●	●	●	●							19
HALICTIDAE																	
HALICTINAE																	
AUGOCHLORINI																	
Augochlora esox Vachal	9	1	0	10	●						●		●	●	●	●	4, 7, 8, 9,14
Augochlora foxiana Cockerell	2	0	0	2									●			●	9
Augochlora morrae Strand	2	1	1	4			●						●			●	4, 9, 19
Augochlorella sp.2	0	1	0	1				●									21
Augochloropsis brachycephala Moure				×													
Augochloropsis callichroa Cockerell				×													
Augochloropsis cockerelli Schrottky				×													
Augochloropsis electra Smith	1	0	0	1									●				18
Augochloropsis patens Vachal	1	0	0	1	●												7
Augochloropsis terrestris prognatha Moure	1	0	0	1										●			15
Augochloropsis smithiana Cockerell	4	0	0	4				●	●	●			●				14, 22
Augochloropsis sp. 1	0	0	1	1											●		9
Pseudaugochlora graminea Fabricius	2	2	0	4			●	●	●								21, 12, 08
HALICTINI																	
Dialictus sp.8	1	0	0	1											●		23
Dialictus picadensis Strand	0	0	1	1				●									4
Pseudagapostemon brasiliensis Cure	2	4	0	6				●	●		●			●			3, 19, 23
MEGACHILIDAE																	
MEGACHILINAE																	
ANTHIDIINI																	
Anthidium latum Schrottky	1	1	1	3				●			●		●				22, 13
Anthidium manicatum L.				x													
Anthidulum zanolae Urban	1	0	0	1										●			13
Anthodioctes megachiloides Holmberg	5	0	2	7							●	●	●				13
Dicranthidium gregarium Schrottky	5	0	2	7								●	●	●			3, 13, 14
Epanthidium tigrinum Schrottky	14	1	4	19				●			●	●	●	●			4, 13, 14, 15, 21
New genus sp.1	3	0	1	4	●							●		●			7, 14

Continue...

Table 1. Continuation

Species	Areas				Months												Visited plant species*
	D1	D2	F	T	J	F	M	A	M	J	J	A	S	O	N	D	
MEGACHILINI																	
Coelioxys sp. 2	2	0	1	3	●									●	●		7, 8
Coelioxys sp. 3	1	0	0	1							●						7
Coelioxys sp. 4	0	0	1	1												●	1
Coelioxys sp.7	0	0	1	1											●		7
Megachile assumptionis Schrottky				x													
Megachile bernardina Schrottky	6	3	3	12	●		●	●									4, 6, 7, 13
Megachiel friesei Schrottky				x													
Megachile micropilosa Schrottky				x													
Megachile paulistana Schrottky				x													
Megachile sussurrans Haliday				x													
Megachile tupinaquina Schrottky	1	0	0	1	●												1
Megachile sp.8	1	1	0	2			●	●									4
Megachile brethesi Schrottky	3	0	1	4								●					
Megachile uniformis Mitchell	3	0	1	4									●			●	4, 8, 13
Megachile (Dactylomegachile) sp.14	1	0	0	1								●					13
Megachile (Dactylomegachile) sp.15	1	0	2	3			●						●		●		13, 9, 22
Megachile (Dactylomegachile) sp.16	1	0	3	4								●			●		9, 13
Megachile (Dactylomegachile) sp. 22	1	0	0	1													13
Megachile sp.17	1	0	0	1											●		4
Megachile sp.18	2	0	0	2												●	4
Megachile laeta Smith	1	0	0	1												●	4
Megachile botucatuna Schrottky	1	0	0	1							●						4
Megachile terrestris Schrottky	1	0	0	1	●												4
Megachile curvipes Smith	1	0	1	2			●		●								5
Megachile neoxanthoptera Cockerell	0	1	0	1							●						4
LITHURGINAE																	
Lithurgus huberi	1	0	0	1					●								4
Collected individuals (n)	223	54	63	350													

* Species of flowering plants represented here by numbers were in Table 4.

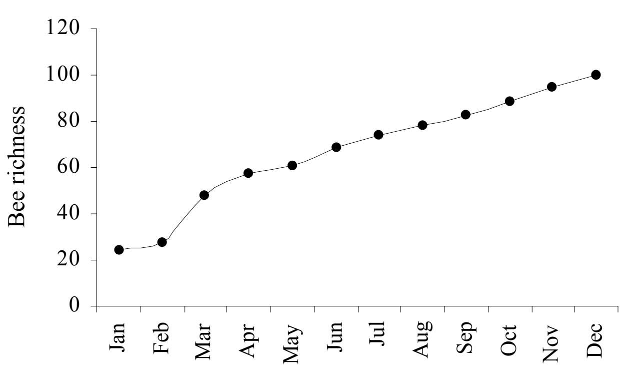

Figure 2. Cumulative number of bee species sampled at the ecological station of UFMG, Belo Horizonte, MG, Brazil, from January to December of 1996.

Forty-one out of the 98 species recorded occurred only in D1, nine only in the forested area, and four only in D2. Species were heterogeneously distributed among sampling areas. The most similar areas were the forested area and D2 (41 %). The similarity between the forested area and D1 and between D1 and D2 were almost the same (30% and 29%, respectively).

Apidae was the richest (56 species) and most abundant (220 individuals) bee family followed by Megachilidae (30 and 92) and Halictidae (13 and 37). Andrenidae and Colletidae both with one species each were rare (Table 1).

The highest richness was found for Megachilini (21), Ceratinini (12), and Apini and Centridini (10 each) (Fig. 3). The highest abundances were found for Ceratinini, Apini, Megachilini and Anthidiini (Fig. 3). The richest genera were *Ceratina*, *Centris*, *Megachile* and *Augochloropsis*.

An average of four bees per sampling hour was collected.

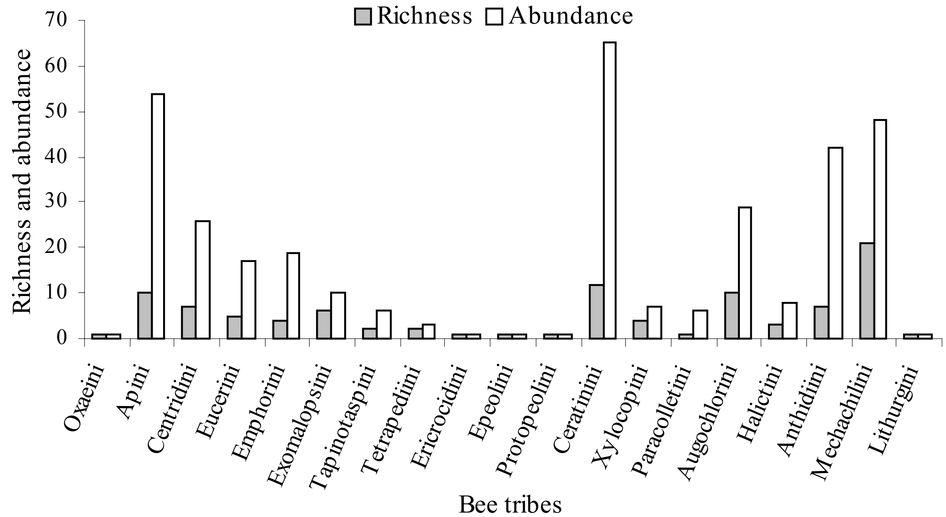

Figure 3. Number of individuals and species distributed by tribe of bee, collected by hour, at the ecological station of UFMG, Belo Horizonte, MG, Brazil, from January to December of 1996.

From August to December, the number of individuals sampled per hour tended to increase, in spite of some months being not typical. In February, for instance, the number of individuals per sampling hour was relatively low, while in March, September, and November, a large number of individuals was collected per hour (Fig. 4).

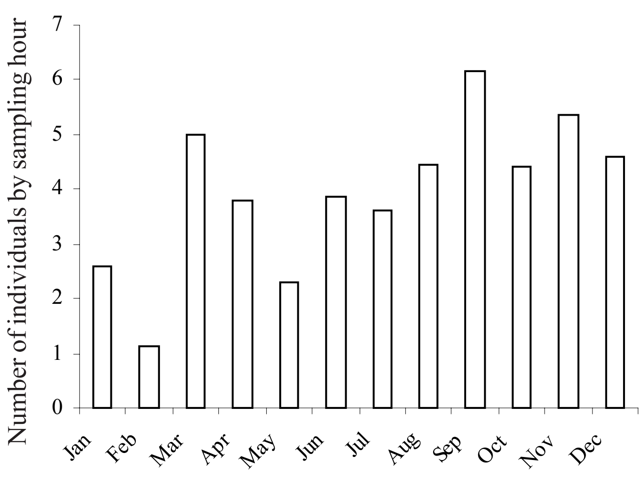

Figure 4. Monthly variation of the number of individual collected at the ecological station of UFMG, Belo Horizonte, MG, Brazil, from January to December of 1996.

In all surveys done in Minas Gerais State, including the present one, Apidae was the most abundant and richer family comparing to Paraná State where Halictidae was the richer and abundant family (Table 2). In Minas Gerais State, Megachilidae was the second richest and abundant family and in Paraná state Apidae was the second richest.

Bee Phenology. Bee species showed seasonality at the ES (Q = 29.35, df = 11, P < 0.002). January and February were the most different months regarding species composition. Two groups of months with close similarity indexes were evident: one in the rainy and the other in the dry period. The highest similarities were observed between March and April (46,5%), July and August (47,8%), September and October (49,3%), October and November (46,2%) (Table 3).

Visits to Flowers. Bees visited 23 plant species in 11 families (Table 4). Considering both number of bee species and individuals the most visited families were Asteraceae (111 individuals from 55 species) and Convolvulaceae (88 individuals from 26 species) (Table 4). Among the Asteraceae, *Cosmus sulphureus* was the most visited. This species was the most abundant in the area and flowering lasted from November until May. The second most visited plant was *Ipomoea cayrica*, whose individuals remained flowering throughout the year. Only six plant species (26%) received most of the bee visits to its flowers (60% of individuals per hour). Species of *Ceratina* e *Melitoma* were collected only in *I. cayrica*. From the total of individuals collected, 10% were *Ceratina*. *Stylosanthes* sp. was visited by 8% of all collected individuals, mainly Megachilidae.

Plant species visited by bee showed no seasonality (Q = 17.30, df = 11, P < 0,099). There was a positive relation between bee abundance and number of flowering plants (r^2 = 0.72, P = 0.0011, n = 12) (Fig. 5). Despite being also positive, the correlation between bee richness and richness of flowering plants was weaker (r^2 = 0.46, P = 0.01, n = 12) (Fig. 6).

Discussion

Despite several avenues surrounding the ecological station of the UFMG, bee species richness (n = 122) is high if compared to those from other natural surveyed areas. For instance, 124 species were found in the cerrado of Corumbataí, and 151 species were collected in the cerrado of Paraopeba (Silveira & Campos 1995). These species, though, showed low abundance in all surveys.

Richness variability among sampling sites demonstrated

Table 2. Percentual contribution of each family to the total number of bee species (except for *A. mellifera* and *T. spinipes*) and to the number of individuals collected at flowers in the Ecological Station of UFMG (ES) and in other areas in Brazil. (VC = Viçosa, PN = Ponte Nova e PP = Paraopeba, MG), CB = Corumbataí SP, PC = Parque da Cidade PR, PB = Passeio Público PR, BV = Boa Vista PR. AD = Andrenidae, AP = Apidae (including Anthophoridae), CO = Colletidae, HA = Halictidae e MC = Megachilidae

	Local	AD	AP	CO	HA	MG	Authors
Species	ES	1.06	55.30	1.06	13.85	28.72	This study
	VC	5.32	37.30	5.90	21.30	30.17	Cure *et al.* 1993
	PN	1.35	40.00	1.34	24.66	32.66	Silveira *et al.* 1993
	PP	0.55	55.20	1.10	18.57	24.60	Silveira & Campos 1995
	CB	2.92	55.20	5.11	16.06	20.45	Silveira & Campos 1995
	PC	13.80	24.60	3.25	42.28	16.26	Cure 1983
	PB	5.40	15.70	4.00	60.80	4.05	Cure 1983
	BV	6.20	30.00	8.10	34.76	21.74	Cure 1983
Individuals	ES	0.30	61.00	1.76	10.56	26.39	This study
	VC	3.73	63.70	2.15	21.48	8.88	Cure *et al.* 1993
	PN	0.20	65.50	0.35	14.07	19.84	Silveira *et al.* 1993
	PP	5.50	80.30	0.18	07.75	6.29	Silveira & Campos 1995
	CB	3.30	69.45	4.05	19.97	3.26	Silveira & Campos 1995
	PC	0.80	32.50	0.76	62.40	3.59	Cure 1983
	PB	1.90	51.50	1.89	24.36	1.36	Cure 1983
	BV	4.20	35.20	4.18	49.79	7.24	Cure 1983

Table 3. Similarity index of the monthly bee species composition on flowering plants at the ecological station of UFMG, Belo Horizonte, MG, Brazil, from January to December of 1996.

	J	F	M	A	M	J	J	A	S	O	N	D
J	*	5.3	24.7	18.2	21.3	19.7	15.9	21.5	15.2	17.9	22.6	21.1
F	*	*	8.5	11.8	9.5	5.7	0.0	0.0	0.0	0.0	0.0	6.5
M	*	*	*	46.5	25.0	31.4	25.0	21.6	24.0	15.8	14.1	12.1
A	*	*	*	*	20.0	24.3	7.9	2.6	12.7	7.5	2.7	8.6
M	*	*	*	*	*	36.4	13.0	16.7	12.2	4.0	8.9	10.0
J	*	*	*	*	*	*	26.7	19.4	19.0	9.4	10.2	14.8
J	*	*	*	*	*	*	*	43.8	52.3	36.4	23.0	21.4
A	*	*	*	*	*	*	*	*	47.8	50.0	31.7	24.1
S	*	*	*	*	*	*	*	*	*	49.3	31.3	40.7
O	*	*	*	*	*	*	*	*	*	*	46.2	43.3
N	*	*	*	*	*	*	*	*	*	*	*	43.6

the among-habitat heterogeneity of the studied site. This can be due to the high habitat diversity at the ES. High variations in fauna composition is believed to be common among different sites within an area (Heithaus 1979, Cure 1983). Besides, areas in early successional stages have a great variability in important habitat components for bees else within narrow habitat areas, such as pollen and nectar sources available in weeds flowers and sites for nesting (Saure 1996; Macedo & Martins 1998, 1999). The highest bee richness found at trails of disturbed areas can be probably due to the highest diversity of weeds occurring in this area.

A higher similarity found between the forested area and D2 was due to the relatively high number of individual of *Solanum lycocarpum* that were intensely visited by *Bombus* spp. in these sites. Besides, the high number of individuals of *Ceratina,* recorded only in the disturbed area, may have also been responsible for the decreasing in similarity between the two disturbed sites.

The number of individuals per month varied during the sampling period. Only in February (due to rainfall) and July and August (dry and cold period), the number of sampled bees was very low. Rainy and/or cloudy days interfere a lot in sampling efficiency once the number of bees active under such circumstances is usually very low.

A similarity of 22% was observed between the bee fauna of the ecological station and that from Paraopeba (Silveira & Campos 1995). The 151 bee species sampled by these authors were from 56 genera and six families (including Anthophoridae, placed with Apidae in this study). Thirty-seven species (20%) were common to both areas. The low similarity observed between the cerrado of Paraopeba and the studied area showed that, although the latter had cerrado components, the differences observed could be due to different nesting substrate conditions, competition for food, or ancient evolution and geographic species distribution patterns (Martins 1990). Comparing the studied area and the abandoned pasture of Ponte Nova, where 150 species have been collected, only 40 species were common to both areas. Considering an area of secondary vegetation at Viçosa (MG), where 98 bee species had been collected

Table 4. Plant species visited by bees at the ecological station of UFMG, Belo Horizonte, MG, Brazil, from January to December of 1996. (IN) Number of individuals, (S) Number of species

Family	Species	S	IN	Bee visitant*
Asteraceae	*Bidens pilosa*	1	1	78
	Baccharis sp.	2	2	6, 10
	Clibadium armanii	7	10	9, 30, 48, 49, 66
	Cosmos sulphureus	36	79	3, 4, 6, 9, 11, 13, 20, 21, 22, 23, 28, 31, 33, 34, 35, 41, 42, 43, 45, 47, 50, 54, 56, 65, 71, 75, 77, 79, 81, 86, 87, 88, 89, 90, 92, 93
	Grazielia intermedia	1	1	91
	Vernonia sp.	7	7	3, 4, 7, 13, 44, 51, 77
	Wulffia baccata	10	11	15, 43, 52, 54, 59, 72, 73, 74, 76, 77
Convolvulaceae	*Bonamia* sp.	11	15	3, 4, 21, 24, 29, 35, 36, 54, 63, 73, 81
	Ipomoea cayrica	16	68	03, 04, 25, 27, 33, 39, 40, 41, 42, 43, 54, 55, 56, 62, 83, 84
	Ipomoea alba	1	5	25
Fabaceae	*Crotalaria* sp.	3	14	9, 46, 52
	Machaerium sp.	7	13	13, 14, 15, 16, 17, 37, 63
	Stylosanthes sp.	12	36	8, 67, 68, 69, 70, 71, 77, 81, 82, 83, 84, 85
	Senna sp.	8	14	14, 27, 43, 54, 61, 70, 71, 72
Labiateae	*Hyptis suaveolens*	5	8	9, 28, 43, 60, 71
Malpighiaceae	*Dicella bracteosa*	2	3	18, 19
Malvaceae	*Sida* sp.	3	4	22, 28, 43
Melastomataceae	*Tibouchina radula*	3	5	9, 11, 58
Onagraceae	*Ludwigia* sp.	7	23	4, 6, 22, 26, 53, 56, 66
Sapindaceae	*Serjania letalum*	1	1	52
Solanaceae	*Solanum lycocarpum*	10	11	3, 4, 13, 14, 28, 29, 32, 57, 63, 71
Verbenaceae	*Lippia* sp.	3	4	61, 63, 83
	Coriandrum sativum	2	3	64, 66

* Names of bee species were in the Table 1.

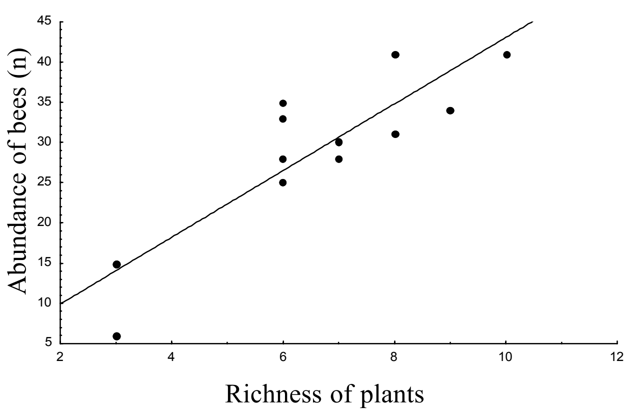

Figure 5. Correlation between abundance of bees and number of flowering plants, from January to December 1996, at the ecological station of UFMG, Belo Horizonte, MG, Brazil.

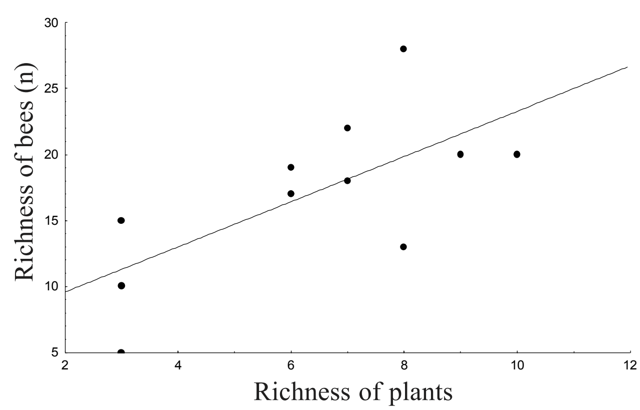

Figure 6. Correlation between richness of bees and number of flowering plants from January to December 1996 at the ecological station of UFMG, Belo Horizonte, MG, Brazil.

(Cure *et al*. 1992), only 17 were common to this area and the ecological station.

Many ecological and historical factors can cause variations in the number of species at different sites. Roubik (1989) mentioned, for instance, availability of suitable sites for nesting, competition for food, and the historical geographic distribution of each group as causes of such variation. In each one of these areas, different species sets will find different conditions and the composition of each species set will depend on the availability of suitable habitats for each species.

Acknowledgments

F.A. Silveira criticisms improved the manuscript and helped with the bee species identifications. P. C.Eterovick helped with English. J. Lombardi identified the plants. The Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) conceded the grant (351892/92-3) and a scholarship to R.P. Martins. The Meteorological Station of the Pampulha Airport provided the temperature and pluviosity data.

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Received 30/12/02. Accepted 15/07/03.